AD-A182 239 TRAVERSE TERRAIN DESCRIPTION FOR MOBILITY TEST AND MODEL EVALUATION(U) BATTELLE-INSTITUT E V FRANKFURT AM MAIN (GERMANY F R) W KOEPPEL ET AL FEB 87 1/1

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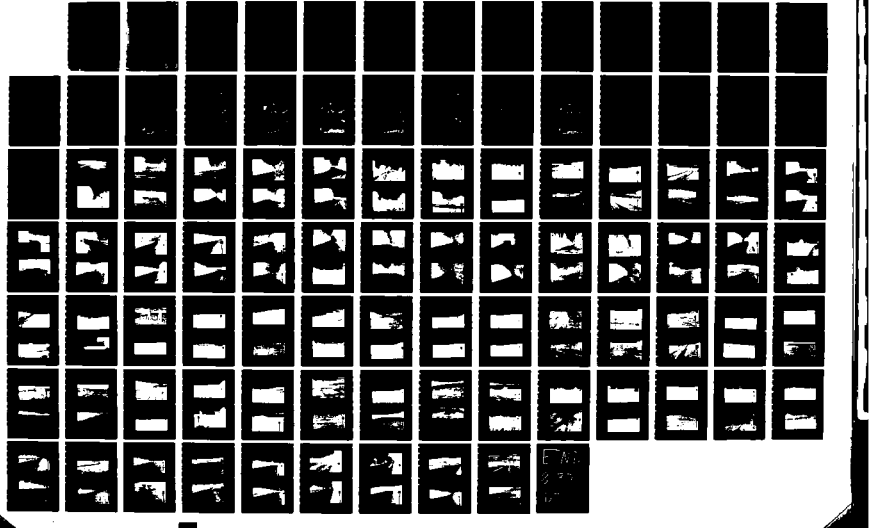

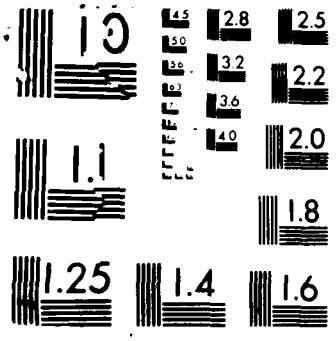
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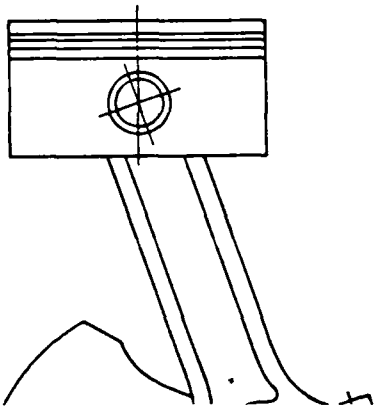

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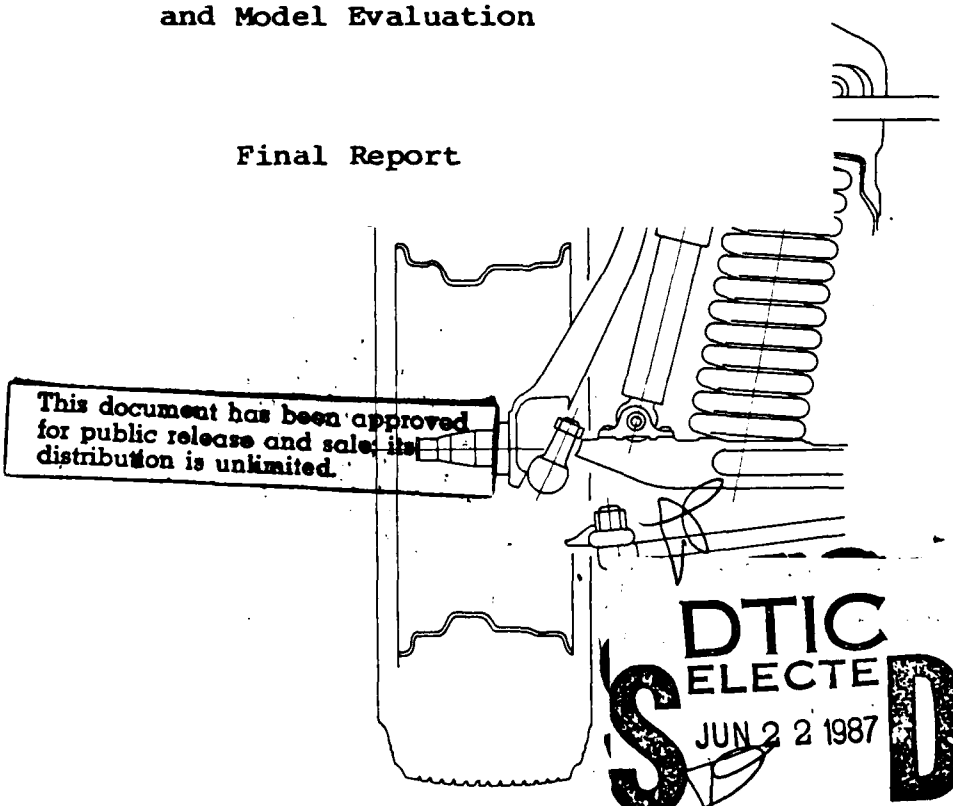
Traverse Terrain Description for Mobility Test and Model Evaluation

Final Report



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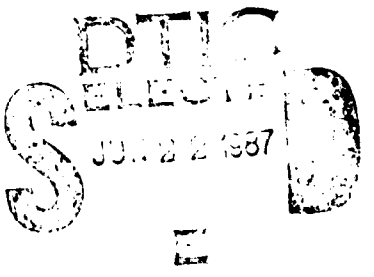


BATTELLE MOTOR- UND FAHRZEUGTECHNIK GMBH

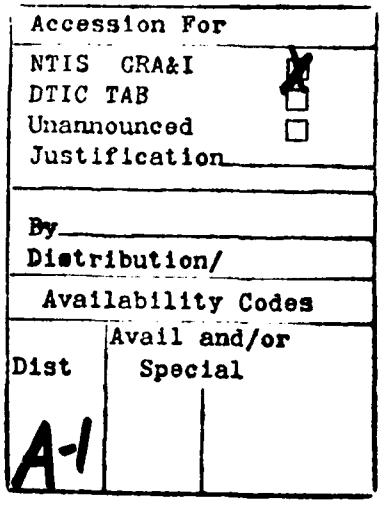
Traverse Terrain Description for Mobility Test and Model Evaluation

Final Report

by

Peter Corvin
Peter Jessl
Werner Köppel

March 1987



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19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

(U) This report contains the description of a traverse terrain selection, evaluation and standard mobility terrain data establishment within a selected military training area at Hammelburg, FRG. Reproducability of the established traverse will be available in order to serve for future comparative vehicle tests.

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C O N T E N T S

FOREWORD

The work reported herin was conducted by Battelle Motor- und Fahrzeugtechnik GmbH (BMF, Battelle Vehicle Technology GmbH) Frankfurt, FRG on behalf of the US Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi, under a contract from the US Army European Research Office, London. It is part of joint efforts by WES and BMF in the field of terrain data acquisition methods activities within the German theater of operations.

The personnel acquiring the various field data included: P. Jessl, P. Corvin and G. Karsubka, BMF. The report was written by P. Corvin, P. Jessl and W. Köppel. W. Köppel was the principal investigator.

ABSTRACT

This report contains the description of a traverse terrain selection, evaluation and standard mobility terrain data establishment within a selected military training area at Hammelburg, FRG. Reproducability of the established traverse will be available in order to serve for future comparative vehicle tests.

Key words:
Traverse terrain data
Mobility

PART I: INTRODUCTION

Background

Mobility of military vehicles can be quantified by the Army Mobility Model (AMM) /1/ of the U.S. Army, which has also become a NATO Reference Mobility Model /2/ in recent years. Computer models like the AMM require - among others - terrain data input for relevant operational or mission tasks within the corresponding theater of operation. Investigating mobility on a traverse (mission-oriented) is the most efficient approach in order to avaluate both model and vehicle capability.

Purpose and Scope

The purpose of the work reported herein was to establish a standard traverse terrain description for the German theater of operation to serve as a traverse terrain data base for relevant mobility tests and computer model evaluation, too.

Steps performed were:

- the selection of a suitable traverse in cooperation with U.S. Army representatives and in succession
- the establishment of a traverse terrain data base prior to the first vehicle tests

The mobility test program addressed above was aimed at generating wheeled vs. tracked vehicles mobility data as part of the NBC Surrogate Reconnaissance System performance evaluation program. Here, the U.S. Army Waterways Experiment Station (WES) had the key coordination role to design and specifiy a suitable vehicle test program.

PART II: TRAVERSE SELECTION

Preselection

After a first inspection of the terrain topographical conditions at the Hammelburg infantry school, a German Army military training area, in November 1985 by personnel of WES, BMF and the Hammelburg U.S. Army liaison officer a preliminary test course was layed out by BMF which incorporated the necessary terrain, road and trail parameters. These included a sufficient traverse length of approximately 22 km, a well balanced distribution of cross-country, road, and field and forest trail segment percentages, as well as a good reproducability of the traverse.

The layout of the course was then discussed in February 1986 between BMF and the responsible commander of the military training area at Hammelburg in order to identify restrictions to be taken into account.

Traverse Layout

The final traverse layout was then agreed upon by WES/BMF members in April 1986 and established on a topographic map sheet of the training area at a 1:10.000 scale.

Additional information obtained by BMF during the layout phase were a tracked vehicle trafficability map of the training area, a CCM-map of the Hammelburg area as well as soil type and bore hole information of the German Mil-Geo agency for the area of interest.

Based on these information, the traverse layout on the available topomap was established; Fig. 1 shows the location of the traverse on the Hammelburg area topo map as well as the bore hole locations.

PART III: TRAVERSE DATA ESTABLISHMENT

Field Inspection

In April 1986 the WES/BMF field team inspected the selected traverse layout at the Hammelburg area and determined the final necessary adjustments to be made. Wet gap crossings were not includable in the traverse due to environmental protection reasons. Generally, the Hammelburg training area is significantly built up by cohesive soils, mainly clayey silts (ML soils) to silty clays, of relatively high soil strength (CI values $\geq$ 200 psi) even for wet condition within the predominating areas which are grass-covered. Slopes are frequently changing with approximately maximum values at the order of 20%.

Traverse Survey

A WES/BMF field team established the traverse terrain data base in terms of standard Army Mobility Model (AMM) terrain input data prior to the vehicle tests in May 1986. During the vehicle test period relevant terrain data were updated, if necessary; this included soil strength values and course deviations which had to be made during the test period. Terrain data were taken on

- slope (including side slopes)
- soil strength
- soil type
- surface roughness
- terrain unit length and altitude
- terrain unit type
- curvature
- drivers's visibility

and provided to the WES team members for detailed evaluation. Available trigonometric points within the test area were connected to the terrain unit sequence in order to allow for quick retrieval of the traverse in case of future repetitive vehicle testing campaigns.

Soil samples were taken at selected sites in order to generate detailed moisture and plasticity limit data (table 1). Also, precipitation values were determined for an adjacent weather station (see tables 2, 3) prior to and during the vehicle test period. Also, the air temperature and precipitation in °C and mm as well as in % of long range mean values are shown in figures 2-9 for describing the meteorological boundaring conditions.
The traverse was approximately 27,5 km long and consisted out of 128 terrain units, composed of many different terrain conditions as

- primary roads
- secondary roads
- tank trails
- field trails
- forest trails
- cross-country areas of varying slopes, roughness, strengths and land-use as meadows, stubble fields etc.

The overall classification into roads, unsurfaced trails and areal cross-country terrain yielded 40% roads, 27% trails and 33% areal terrain.

Photos 1-128 show the views of the terrain units which were identified on the traverse.

Photos 129-130 indicate the consecutive terrain conditions met on terrain units 58 and 59 as well as 87 and 88 which are quite representative for the majority of the cross-country meadow segments of the traverse.

PART IV: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the traverse terrain data established within the Hammelburg training area and the vehicle tests performed in May 86 it can be concluded tnat for future test programs a suitable course has been identified which is easily reproducable and accessible.

Recommendations

It is recommended that the Hammelburg course available should be used as an F.R.G. reference course for future mobility test programs to allow for comparisons of competitive vehicles.

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/2/ Haley, P.W.; Jurkat, P.M.; Brady, P.M.:
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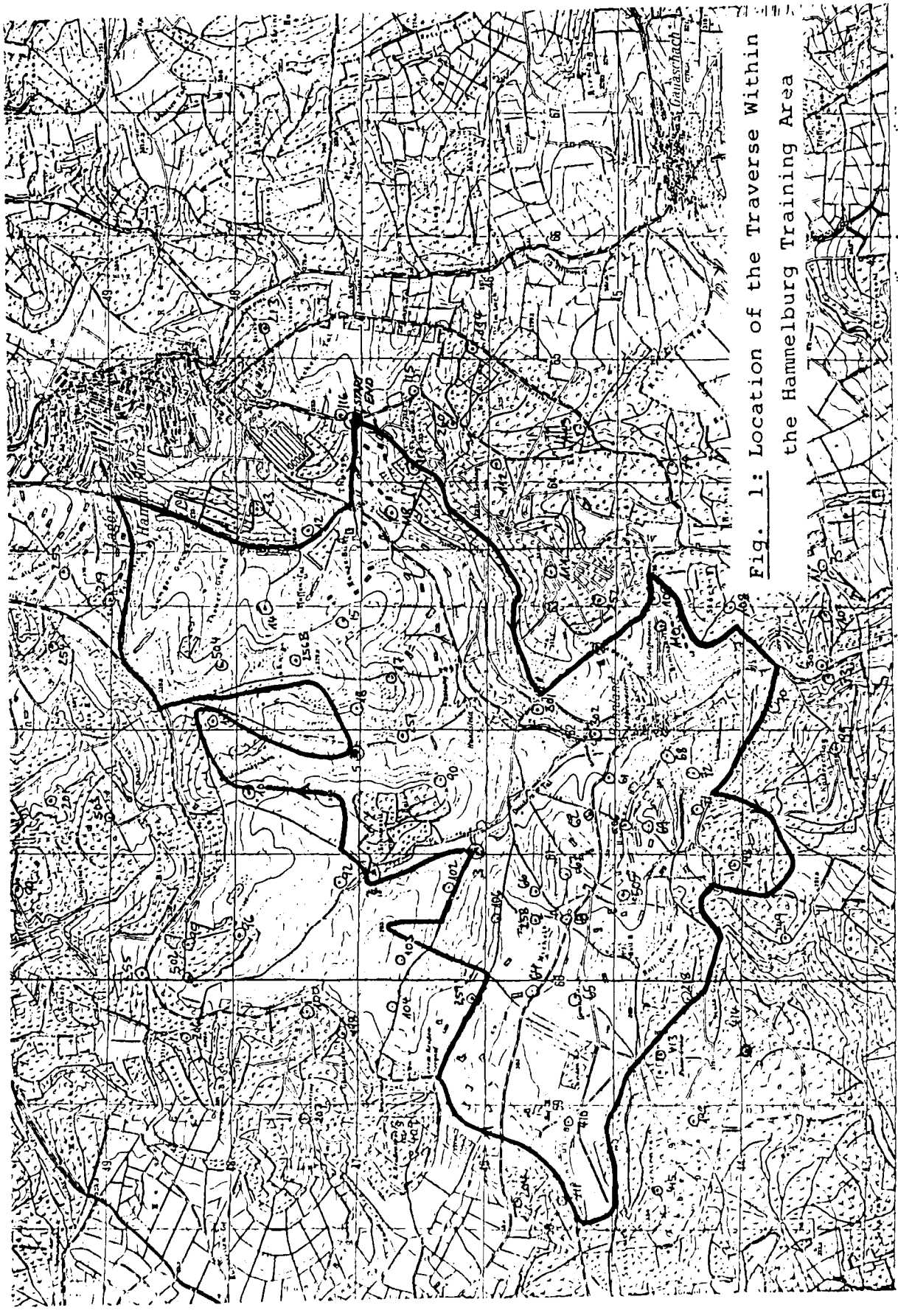

Fig. 1: Location of the Traverse Within the Hammelburg Training Area

April 1986

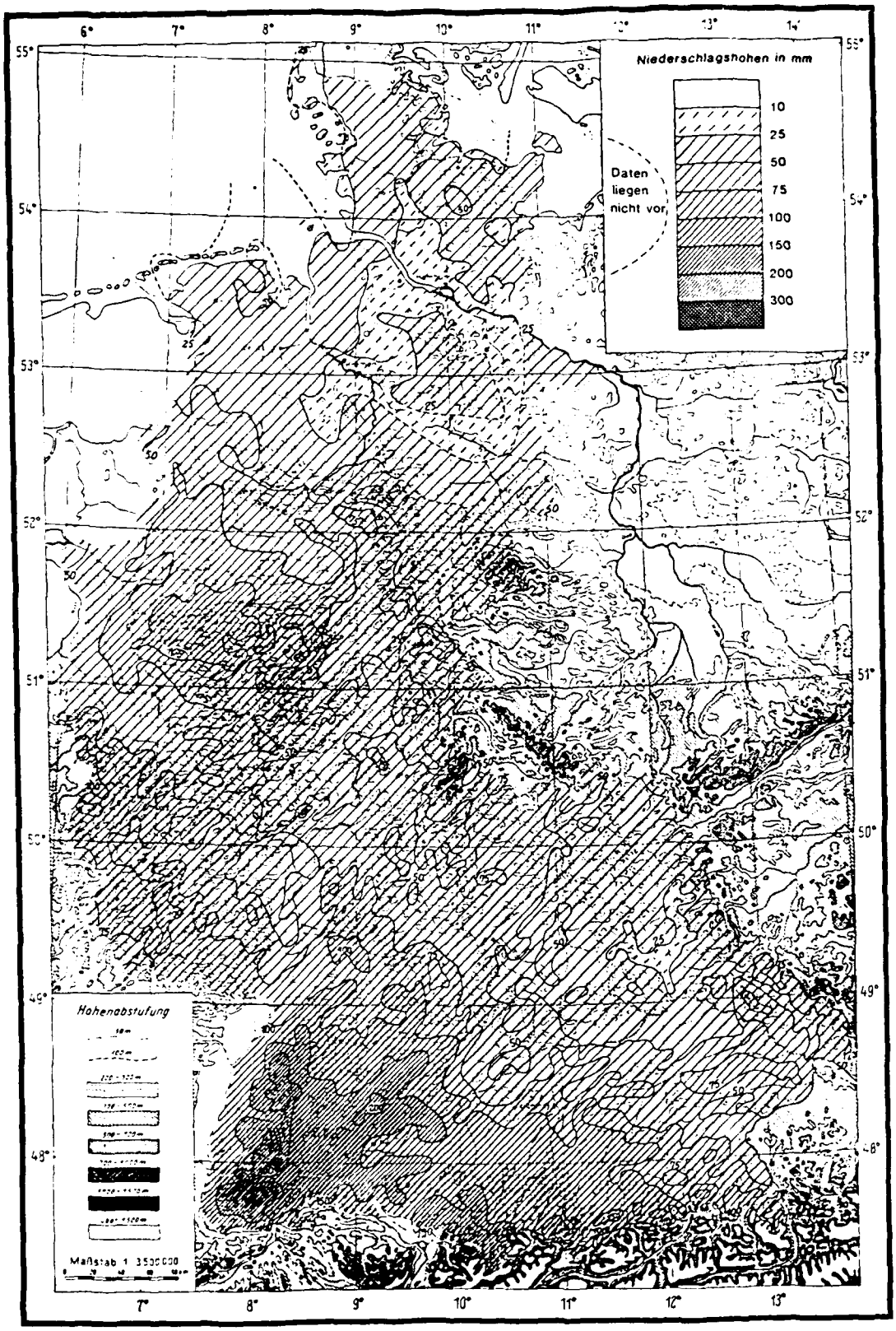

Fig. 2: Distribution of Precipitation in mm (April 1986, FRG)

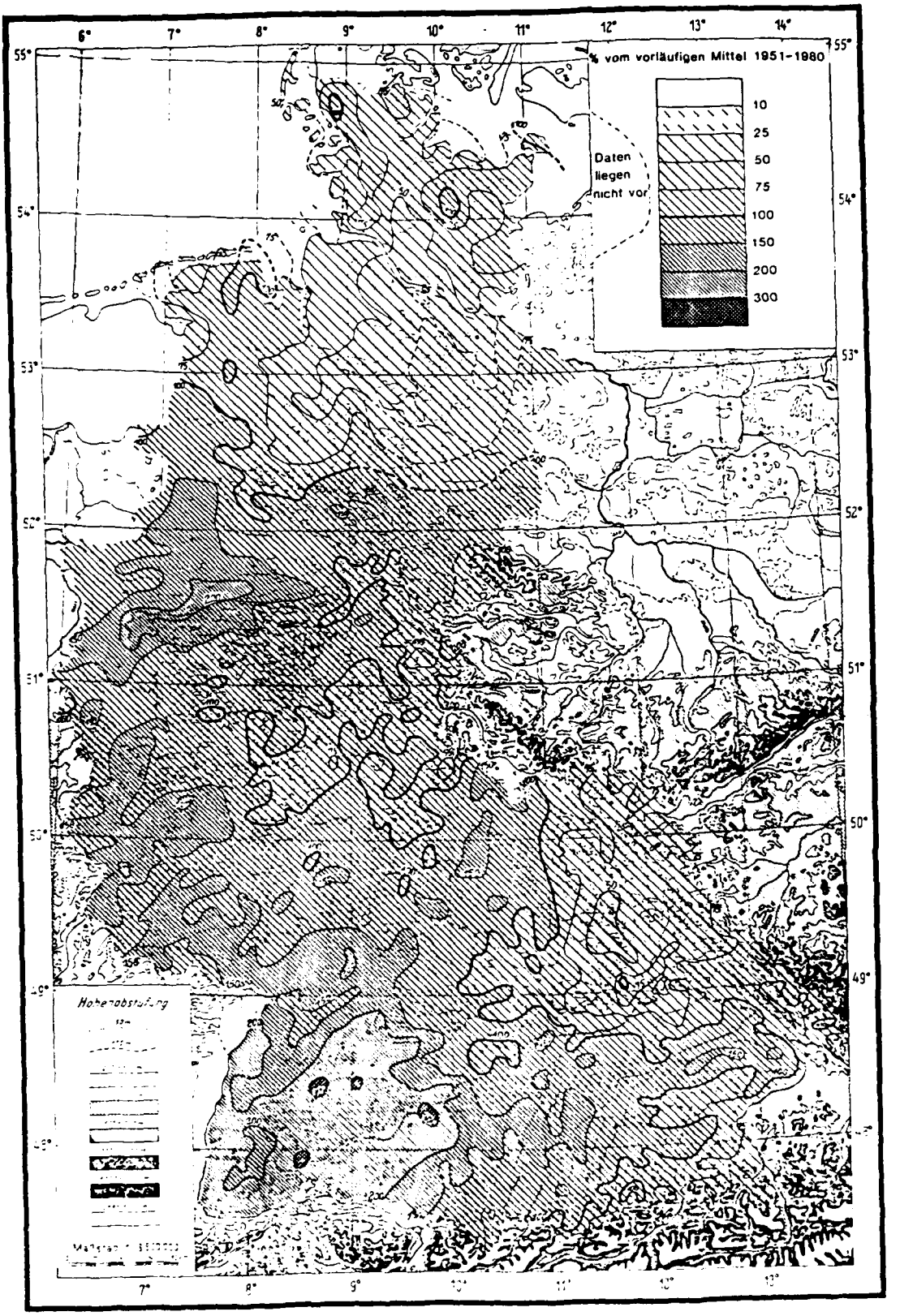

Fig. 3: Distribution of Precipitation in % of Long Range Average Values 1951-1980 (April 1986, FRG)

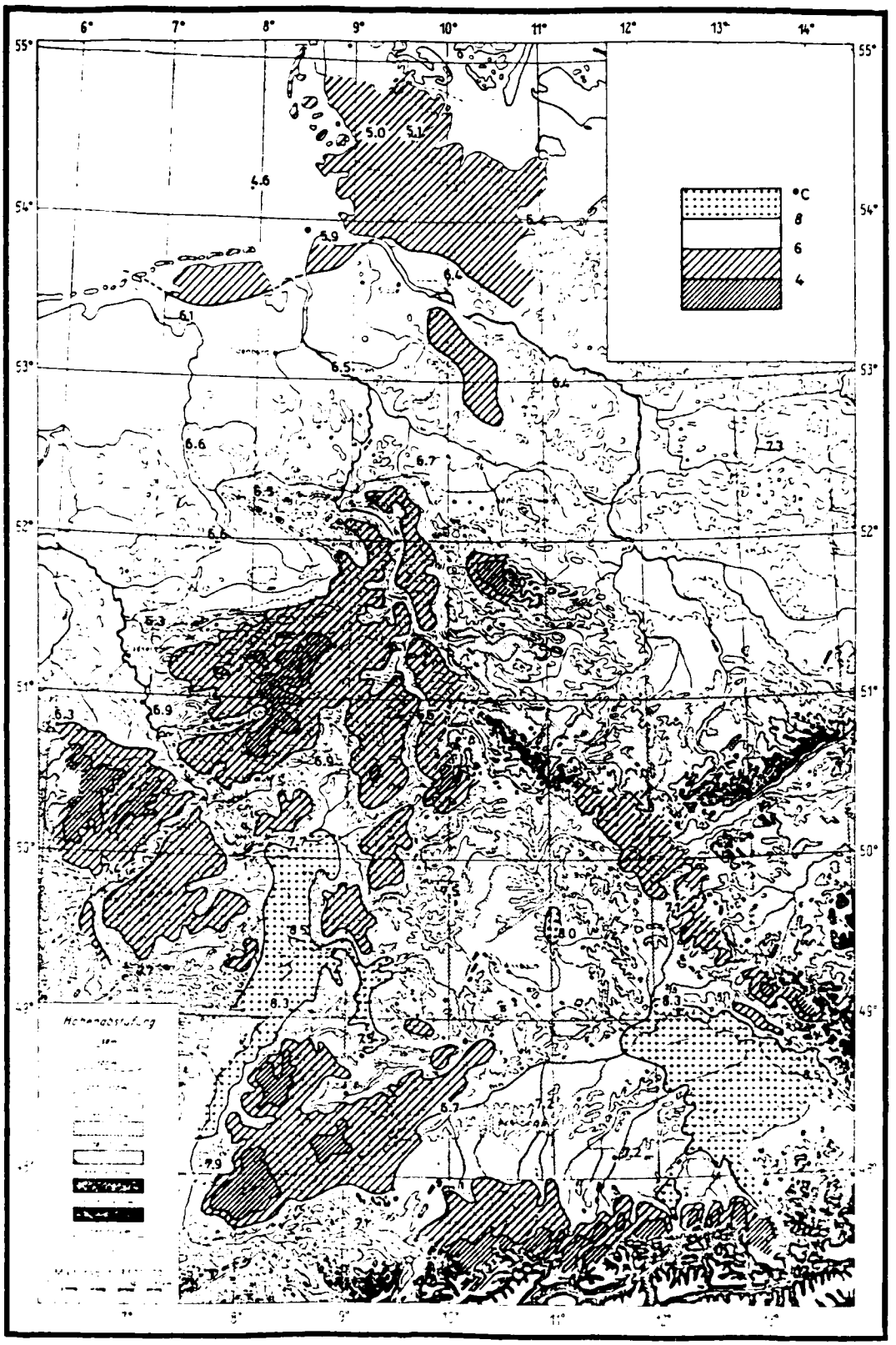

Fig. 4: Monthly Mean Values of Air Temperature in °C (April 1986, FRG)

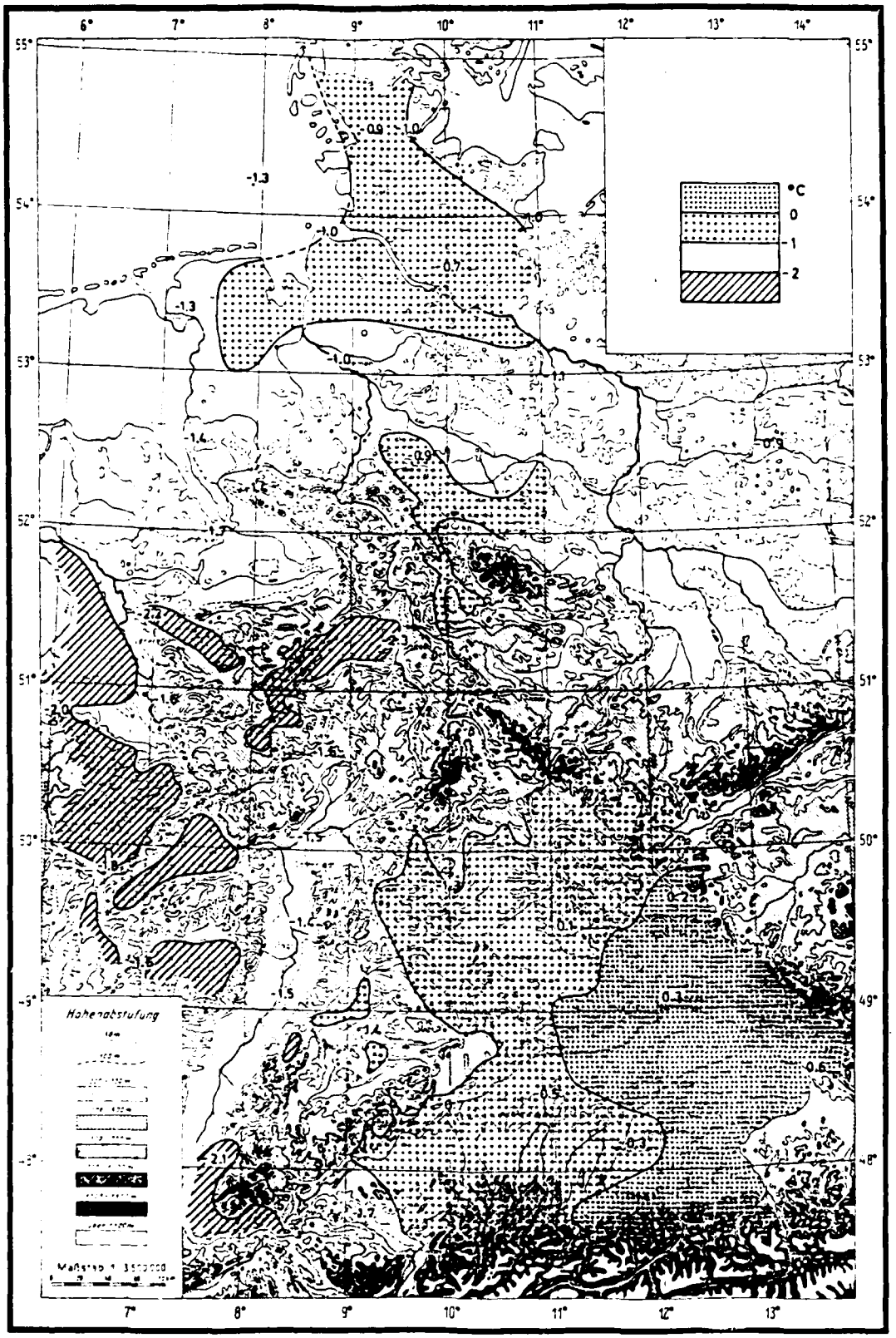

Fig. 5: Deviation of Monthly Mean Air Temperature
Value from 1951-1980
Value in °C (April 1986, FRG)

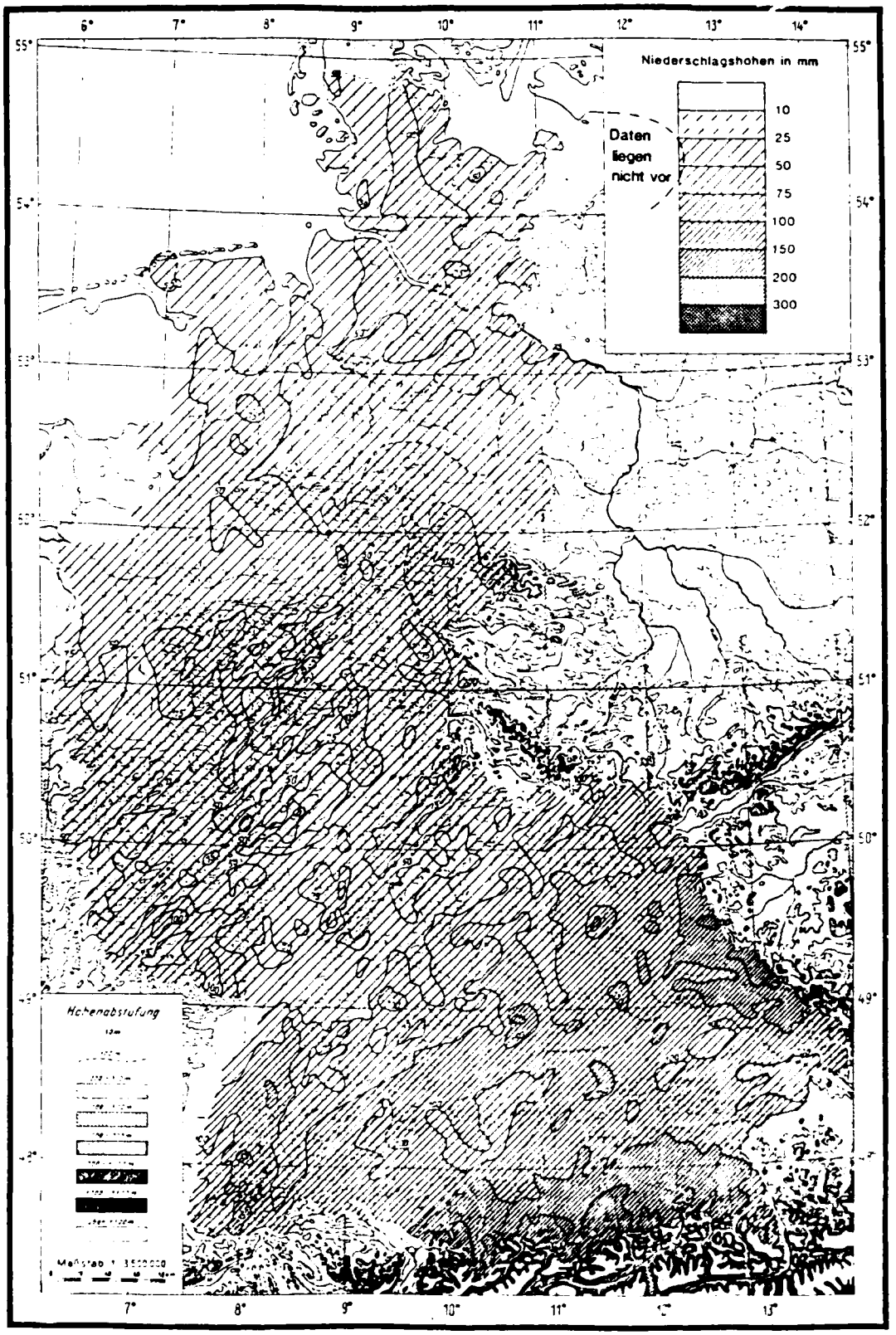

Fig. 6: Distribution of Precipitation in mm
(May 1986, FRG)

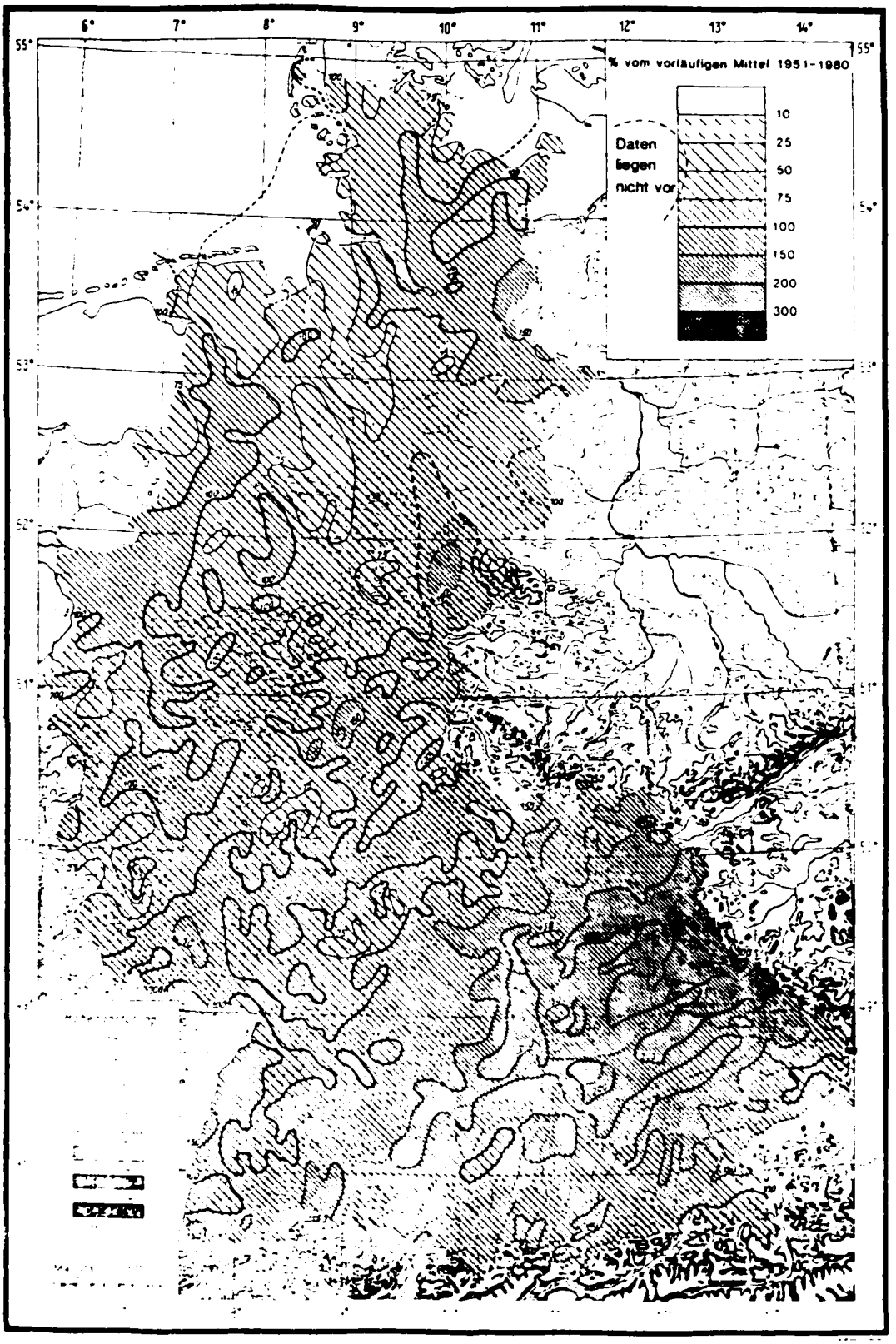

Fig. 7: Distribution of Precipitation in % of Long Range Average Values 1951-1980 (May 1986, FRG)

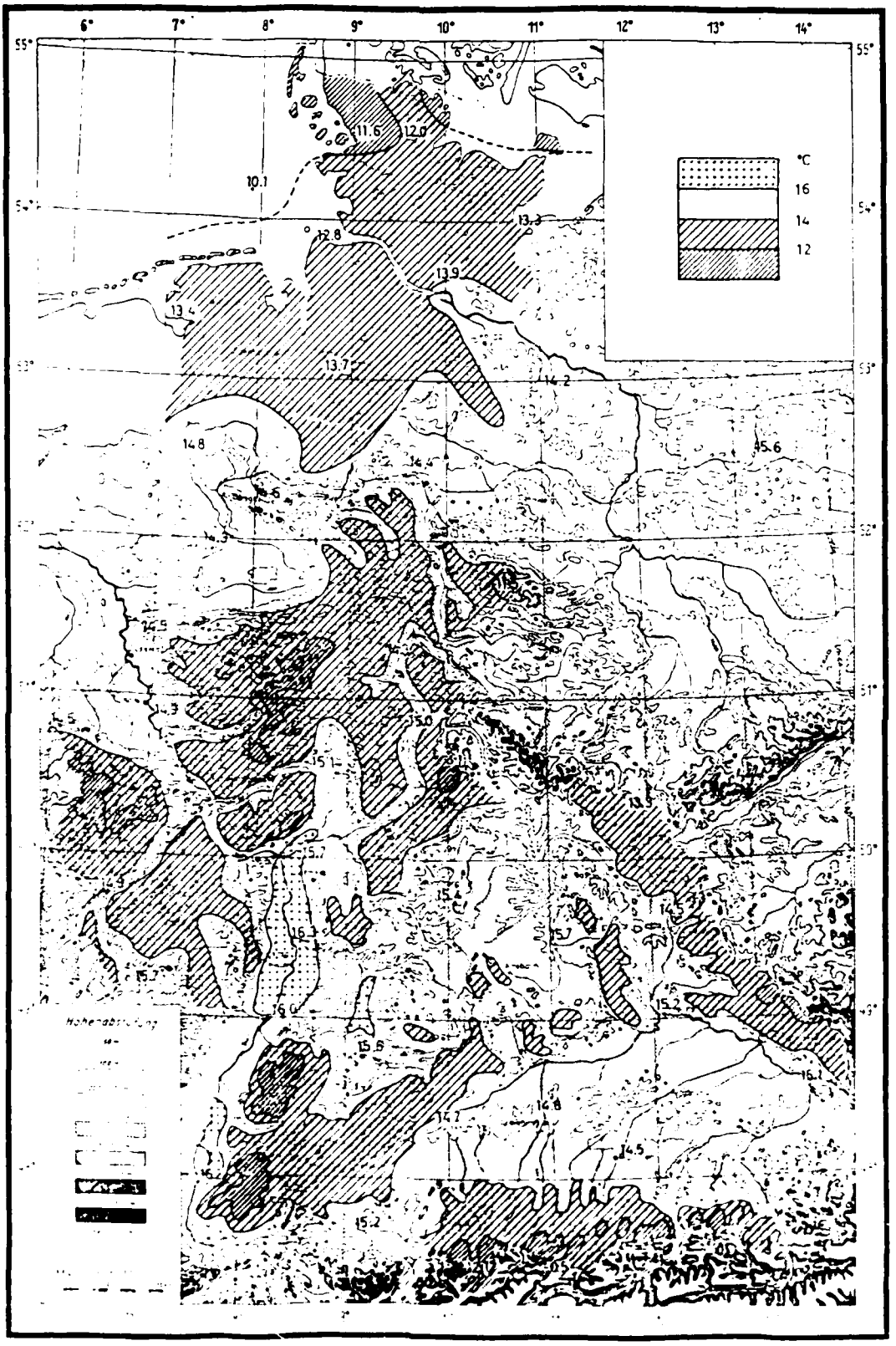

Fig. 8: Monthly Mean Values of Air Temperature in °C (May 1986, FRG)

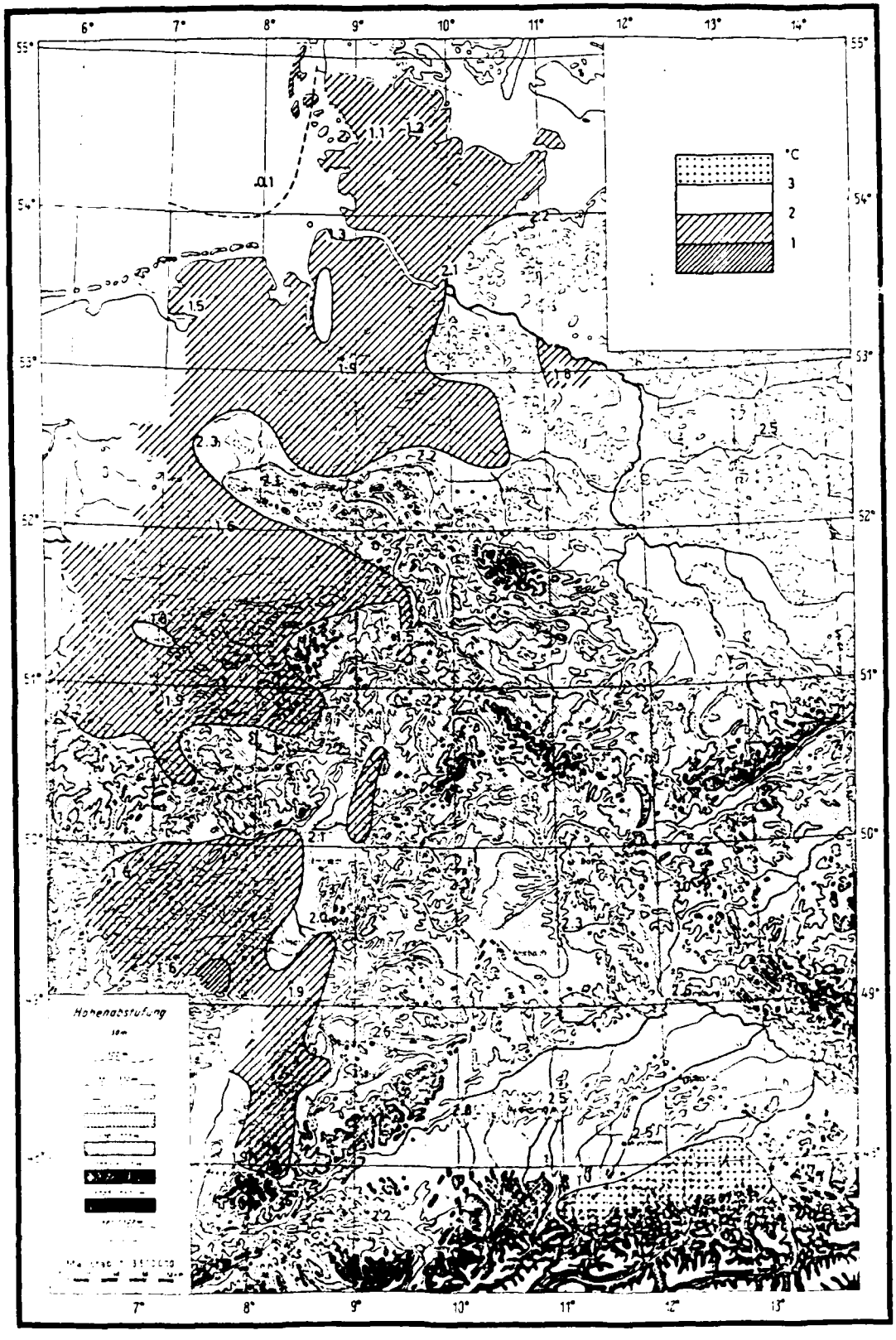

Fig. 9: Deviation of Monthly Mean Air Temperature Values from 1951-1980 Value in °C
(May 1986, FRG)

List of Tables

Table 1: Soil Sample Data for the Hammelburg Test Area

Terrain Unit Sample No.	UTM Grid Coordinates	Recording Date	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	USCS Field Soil Type	Soil Strength (psi)
15	623/455	16/05/86 17/05/86 22/05/86	25.8 25.6 23.8	30.5 30.5 30.8	57.8 57.8 54.6	CL-CH	182 230 203
18	626/451	16/05/86 17/05/86	19.5 16.2	22.3 21.1	38.5 35.9	CL-ML	235 270
68	610/461	16/05/86 17/05/86	31.3 24.7	33.1 33.1	52.4 52.4	CL-CH	170 232 238
76	609/469	16/05/86 17/05/86	27.5 25.5	24.1 24.1	37.8 37.8	ML	132 179 169
99	619/471	16/05/86 17/05/86 18/05/86 22/05/86	25.3 22.5 22.4 23.4	24.1 22.5 22.5 24.2	39.8 35.9 35.9 42.1	ML	79 91 114 94

Table 2: Daily Precipitation Data for the Nearest Weather Station Schweinfurt in April 1986

Tägliche Niederschlagshöhen (mm)

– von 7 Uhr mittlerer Ortszeit des angegebenen Tages bis 7 Uhr des Folgetages –

April 1986

Station	Höhe über NN in m	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Monat Month
Pirmasens	280	.	9	10	.	.	0	.	.	1	3	0	.	2	5	0	5	3	2	5	5	11	1	3	1	0	15	.	2	2	.		83
Trier (Stadt)	144	0	.	6	0	0	3	.	.	1	4	0	.	1	4	3	.	1	0	7	6	26	.	1	3	7	5	.	0	0	.		78
Trier-Petrisberg (WA)	265	0	0	6	0	0	3	0	.	0	4	0	.	1	10	3	0	1	0	4	5	27	0	1	4	6	4	0	0	1	.		81
Manderscheid/Eifel	403	0	.	3	.	.	3	.	.	0	3	0	.	4	8	5	0	1	1	2	10	22	.	1	1	2	10	.	.	1	.		76
Bernkastel	120	.	0	7	1	0	1	0	.	1	2	0	.	1	6	2	.	3	0	4	3	17	0	.	1	3	9	.	0	0	0		59
Blankenrath	400	.	.	8	1	1	2	1	.	1	6	0	.	2	7	2	.	0	1	5	4	19	1	.	0	7	15	.	.	2	.		87
Neuwied Wollendorf	121	1	.	7	2	1	0	1	.	0	2	0	.	0	1	.	.	2	2	1	2	17	.	0	0	3	9	.	.	0	.		52
Nürburg (Wst)	627	1	.	6	3	2	2	.	0	3	7	1	0	1	2	6	0	1	3	3	3	16	.	0	1	6	14	0	.	5	0		84
Bad Marienberg (Wst)	547	2	.	16	7	0	0	0	.	1	3	0	.	2	4	0	0	4	9	2	4	12	0	0	.	0	11	.	.	0	.		77
Baden-Württemberg																																	
Tauberbischofsheim	691	.	.	19	6	0	.	.	.	35	7	5	4	0	.	.	0	6	6	12	16	.	0	.	1	.	0	1	6	20	4		148
Aulendorf	571	.	0	11	2	4	.	.	.	54	6	1	1	.	.	.	5	5	4	5	5	0	1	0	2	0	1	2	1	18	22		150
Stockach	475	.	1	11	0	6	.	.	.	52	19	1	.	.	.	.	2	5	6	4	8	.	2	0	13	.	.	4	2	11	13		160
Aach, Kr. Konstanz	478	.	4	8	1	10	.	.	.	52	9	0	0	.	.	.	2	4	3	3	5	.	3	0	13	.	.	4	3	10	2		135
Hochenschwand	1008	.	12	26	0	8	0	.	.	12	7	1	6	0	0	.	5	12	13	10	25	1	12	.	10	.	6	1	4	7	3		181
Schopfheim	400	.	17	39	.	10	1	.	.	21	3	1	2	.	0	0	7	9	7	7	18	7	19	.	6	.	2	4	4	6	2		191
Oberlotweil	523	.	9	15	0	0	0	.	.	1	9	0	0	.	0	0	3	6	3	2	2	13	31	1	6	0	6	3	7	6	.		123
Triberg	583	.	26	23	1	6	1	.	.	21	14	1	1	1	3	2	5	12	6	13	29	8	16	.	9	0	10	3	7	19	.		235
Rheinau Freistett	131	.	14	10	.	.	.	.	.	2	7	0	.	.	.	0	1	0	9	7	5	21	22	2	2	.	22	0	1	12	.		136
Hornisgrinde	1150	0	13	21	0	0	.	.	.	12	12	2	3	2	3	1	6	5	23	25	19	19	26	.	1	0	20	0	2	10	0		224
Hechingen	520	.	14	23	0	1	0	.	.	16	21	1	0	0	0	.	1	2	1	7	6	3	11	0	17	0	11	3	3	37	0		180
Stuttgart (Schnarrtenberg WA)	314	0	12	10	0	0	1	.	.	8	11	0	0	.	0	.	0	2	1	0	3	3	9	0	9	.	20	0	3	25	.		117
Waldbad (Stadt)	417	.	14	6	0	1	0	.	.	20	18	2	0	.	0	.	1	1	4	13	3	6	14	1	4	.	14	0	3	10	.		133
Heilbronn	167	.	15	6	0	.	.	.	.	9	11	0	0	.	3	.	2	0	0	4	3	4	11	0	6	0	10	0	3	0	.		88
Ellwangen/Jagst	443	.	4	18	0	1	1	.	.	6	7	3	0	0	.	.	1	1	1	4	4	.	1	1	4	0	6	1	1	0	.		63
Heidelberg	111																																
Wertheim Eichel	140	.	7	5	1	.	.	.	.	2	2	.	.	.	0	.	2	1	1	2	5	2	5	1	2	4	6	.	.	.	.		48
Sigmaringen	650	.	6	8	0	7	0	.	.	46	16	1	0	0	0	.	1	3	3	2	7	.	5	0	11	.	.	2	7	11	4		139
Munsingen	721	.	7	16	.	7	0	.	.	40	8	1	0	0	.	.	1	5	1	8	13	0	8	1	14	.	0	3	4	26	3		165
Heidenheim/Brenz	500	.	3	11	.	4	.	.	.	5	5	1	0	0	.	.	.	1	1	4	7	.	1	0	2	.	2	.	.	19	.		65
Bayern																																	
Hof-Hohensaas (Wst)	567	0	6	7	1	0	0	.	0	2	3	1	0	.	0	.	.	1	4	2	1	0	0	0	7	3	0	0	0	.	.		37
Teuschnitz Wickendorf	560	.	5	5	0	.	.	.	.	1	14	1	0	.	0	.	1	.	2	6	6	1	2	.	10	10	2	1	.	.	.		68
Weißenburg/Bay. (Wst)	422	.	1	9	0	1	0	.	.	0	9	1	0	0	.	.	1	1	3	2	1	0	0	.	3	.	9	.	1	1	0		41
Nürnberg Kraftshof (Flugh.)	310	.	2	11	0	0	0	.	.	4	8	1	0	0	0	.	0	0	1	1	1	0	0	.	3	0	16	0	0	0	0		46
Gutwenstein	450	.	3	8	0	.	0	.	.	0	6	1	.	.	1	.	0	.	0	2	4	.	.	.	7	0	4	0	1	.	.		37
Schweinfurt	240	.	8	5	0	.	.	.	.	2	7	.	.	.	2	.	2	.	2	1	2	5	5	0	3	8	8	.	.	.	.		59
Würzburg (Wewa)	268	.	10	6	0	.	.	.	.	0	3	0	0	0	0	.	4	0	1	2	2	4	4	.	3	3	8	0	0	0	.		51
Ostheim/Rhön	315	.	4	5	1	.	.	.	.	.	7	.	.	.	3	.	4	.	2	2	1	2	4	.	1	5	9	0	.	.	.		51
Steinbach b. Lohr/Main	161	.	5	5	1	.	.	.	.	0	1	0	.	0	2	.	2	1	1	4	5	2	8	1	1	0	6	.	.	.	.		46
Frammersbach	345	0	5	6	1	0	.	.	.	0	2	0	0	0	7	.	9	2	1	4	5	2	5	0	1	0	6	.	.	.	.		57
Rothenburg o. d. Tauber	406	.	10	10	0	.	0	.	.	3	7	0	0	0	1	.	0	1	1	0	1	0	2	.	7	3	5	0	.	0	.		53
Kempten (Wst)	705	.	.	7	10	1	.	.	.	22	5	10	9	0	.	.	0	7	3	8	6	0	0	.	1	.	0	0	5	13	9		116
Krumbach Edenhausen	520	.	.	13	0	1	.	.	.	12	4	2	5	0	.	.	.	4	7	4	5	.	0	.	1	.	4	0	10	10	15		93
Kaisheim Neuhof	516	0	0	10	0	1	.	.	.	.	14	1	0	1	0	.	.	1	2	3	2	0	0	.	3	.	7	0	13	8	.		67
Schwangau Horn	796	.	.	12	6	1	.	.	.	43	6	19	16	0	.	.	.	8	7	11	5	.	.	.	.	.	.	0	0	2	23	10		151
Kaufering	545	.	.	14	7	2	.	.	.	8	6	8	6	.	.	.	4	5	8	14	9	.	.	.	.	.	.	0	6	13	19		129
Kosching	417	.	.	8	0	1	.	.	.	1	6	1	1	0	.	.	1	3	12	2	2	.	.	.	1	.	.	.	1	1	0		40
Au i. d. Hallertau/Günzenhausen	483	.	.	6	2	3	.	.	.	1	9	6	3	1	.	.	8	5	7	3	2	.	.	.	0	.	.	.	5	8	6		73
Parsberg Opf.	542	.	.	5	.	1	.	.	.	1	5	1	1	0	.	.	1	4	3	2	2	.	.	.	2	.	.	.	3	.	.		30
Obervierlbach	498	.	.	7	1	1	0	.	.	1	8	1	0	.	0	.	0	5	4	1	2	.	.	.	0	.	.	0	1	.	1		33
Amberg Unterammerricht	366	.	0	5	1	0	0	.	.	3	5	0	1	.	0	.	1	3	2	1	1	.	.	.	4	.	.	.	1	2	.		30
Hallenstein Kraftwerk	403	.	.	6	2	1	.	.	.	.	7	1	1	.	.	.	3	7	13	1	2	.	.	.	.	.	.	.	1	0	1		44
Regensburg (Wst)	366	.	.	2	0	0	.	.	.	0	5	2	0	0	0	.	2	3	2	1	0	.	.	.	1	.	.	.	2	.	0		21
Weihenstephan (AMBF)	467	.	.	7	4	2	.	.	.	1	5	7	2	0	.	.	1	1	6	5	3	0	.	.	0	.	.	.	19	14	2		77
München Nymphenburg	515	.	0	12	6	1	.	.	.	7	7	7	3	1	.	.	1	2	16	7	7	.	.	.	0	.	.	0	8	11	4		100
Kümhausen	435	.	0	5	4	2	.	.	.	0	.	13	2	1	.	.	2	.	12	4	4	.	.	.	1	.	.	.	8	16	1		81
Freyung v. Wald	645	0	.	2	5	2	.	.	.	.	6	1	0	1	.	.	2	.	13	4	8	.	.	.	.	.	.	0	4	.	6		54
Rosenheim	445	.	.	7	4	0	.	.	.	9	10	12	6	0	.	.	.	0	8	1	5	.	.	.	.	.	.	.	1	2	5		70
Mühldorf/Inn (Wst)	401	.	.	4	2	0	.	.	.	.	3	11	3	0	.	.	2	3	10	2	5	0	.	.	.	.	.	.	1	1	2		50
Kötzting	611	0	.	9	5	1	.	.	.	1	11	10	6	0	.	.	.	0	16	6	11	0	.	.	.	.	.	0	4	1	3		83
Trostberg	487	.	.	5	5	.	.	.	.	4	6	8	4	0	.	.	.	4	11	2	8	1	.	.	.	.	.	1	5	10	4		78

Month

Table 3: Daily Precipitation Data for the Nearest Weather Station Schweinfurt in May 1986

Tägliche Niederschlagshöhen (mm)

– von 7 Uhr mittlerer Ortszeit des angegebenen Tages bis 7 Uhr des Folgetages –

Mai 1986

Station	Höhe über NN in m	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Monat
Primasens	280	.	4	3	0	6	10	5	1	.	9	.	0	20	2	0	3	.	3	6	2	3	.	1	6	.	.	1	4	0	5	.	94
Trier (Stadt)	144	.	2	4	.	1	1	0	2	0	6	.	.	5	0	1	.	.	1	1	1	1	.	7	1	.	.	0	2	.	1	.	36
Trier Petrisberg (WA)	265	.	4	4	.	1	0	0	2	0	6	.	.	5	0	0	.	0	3	1	1	1	.	9	1	.	.	1	2	.	0	.	43
Prüm/Schneifel/Eifel	403	.	2	3	.	4	1	0	4	1	2	.	.	8	1	1	.	.	9	0	1	0	.	9	3	.	.	2	2	3	1	1	64
Bernkastel	120	.	12	3	0	1	7	0	1	0	2	.	.	8	1	1	.	.	9	5	1	0	.	16	3	.	.	2	0	6	.	.	70
Blankenrath	400	.	0	5	.	3	7	2	4	1	1	.	.	5	.	1	.	.	1	0	1	.	.	18	5	.	.	0	0	0	1	.	58
Neuwied Wollendorf	121	.	.	4	0	1	6	0	6	3	2	.	0	8	1	0	.	.	1	0	1	.	.	16	2	.	.	0	0	3	1	.	64
Nurburg (Wst)	627	.	.	3	0	2	1	.	13	2	7	0	0	11	1	1	.	0	0	0	1	0	.	16	2	.	.	5	1	1	.	.	73
Bad Marienberg (Wst)	547	.	.	1	.	0	6	3	7	7	6	.	0	6	2	1	.	0	3	0	0	0	0	18	4	.	.	5	1	1	.	.	73
Baden-Württemberg																																	
Tuty	691	.	.	2	.	.	.	25	1	0	.	5	.	1	1	9	9	0	1	6	0	17	.	20	6	.	0	18	13	16	19	3	170
Aulendorf	571	.	.	.	.	.	.	21	0	0	0	3	.	.	3	6	13	.	1	0	0	4	.	9	.	.	3	20	6	7	4	2	102
Stockach	475	.	.	.	.	.	.	11	1	.	.	0	.	.	1	5	5	18	.	1	.	1	5	.	5	.	.	.	16	13	19	6	8	115
Aach, Kr. Konstanz	478	.	.	.	.	.	1	13	0	0	.	3	0	2	4	3	18	.	6	0	.	5	.	24	0	.	.	11	7	14	3	4	118
Hochenschwand	1008	.	.	.	.	.	2	22	.	.	2	2	.	0	2	5	20	.	4	1	4	12	.	3	2	.	2	22	5	7	2	3	120
Schopfheim	400	.	.	.	.	.	3	20	.	.	0	4	0	0	1	8	21	.	4	1	4	6	.	1	2	.	7	24	7	7	0	0	118
Oberrotweil	223	.	.	2	.	1	9	6	0	0	3	3	.	2	1	2	14	1	2	0	2	0	.	20	2	.	.	13	2	7	3	.	94
Triberg	683	.	2	1	.	1	5	21	1	.	4	6	.	2	2	8	20	.	4	0	1	10	.	15	5	.	1	13	1	3	6	0	132
Rheinau Freistett	131	.	.	1	.	0	7	4	2	0	10	1	.	6	2	7	7	.	3	1	2	3	.	2	1	.	.	19	2	3	3	.	86
Hornisgrinde	1122	.	0	.	.	1	20	10	4	1	11	1	.	4	3	3	12	.	3	2	0	6	.	3	6	.	.	18	3	10	13	.	132
Hechingen	520	.	0	2	.	.	14	20	1	.	2	2	.	1	3	2	13	.	5	0	2	6	0	1	2	.	0	9	7	4	7	2	104
Stuttgart (Schnarrenberg, WA)	314	.	.	.	.	0	7	10	2	0	4	1	.	2	4	0	8	0	5	0	0	4	.	8	1	.	.	7	8	0	3	2	77
Wildbad (Stadt)	417	.	0	0	.	.	10	7	2	.	8	0	.	5	2	1	11	.	1	1	.	1	.	4	6	.	.	13	2	5	9	1	86
Heilbronn	167	.	.	.	.	.	5	5	1	0	10	3	.	7	3	1	7	0	0	2	0	2	.	5	4	.	.	5	3	5	4	.	70
Ellwangen/Jagst	443	0	.	9	.	.	0	11	1	.	6	6	.	2	3	1	8	.	0	4	1	4	.	1	1	.	.	10	5	2	8	4	86
Heidelberg	111	.	.	.	2	16	11	2	2	0	5	.	.	4	2	1	2	.	1	6	0	1	.	0	4	.	.	2	0	9	0	0	68
Wertheim/Eichel	140	.	.	7	.	0	1	0	3	0	4	.	0	9	3	.	0	.	0	4	0	1	.	0	0	.	.	11	0	0	2	.	46
Sigmaringen	650	.	0	.	.	.	.	12	.	1	.	2	.	2	7	4	14	.	3	6	1	6	.	8	0	.	.	5	13	10	6	7	108
Munsingen	721	.	17	.	.	1	.	20	0	1	0	4	.	5	3	2	19	.	7	2	1	13	.	3	3	.	.	6	7	5	7	2	128
Heidenheim/Brenz	500	.	.	2	.	0	3	10	0	.	1	3	.	11	4	3	18	0	14	0	0	3	.	22	3	.	.	8	18	2	7	2	135
Bayern																																	
Hof Hohensaas (Wst)	567	.	.	.	0	22	.	24	1	0	5	0	.	7	0	3	.	.	0	6	0	1	.	.	4	.	.	5	4	24	10	3	117
Teuschnitz Wickendorf	560	.	.	.	3	1	1	14	1	0	9	1	.	3	1	4	.	.	2	5	.	2	.	2	8	.	.	1	5	14	13	7	96
Weißenburg/Bay. (Wst)	422	0	.	.	.	1	.	15	1	0	1	5	.	5	2	3	10	0	.	3	0	4	.	11	3	.	.	5	7	5	6	2	89
Nürnberg Kraftshof (Flugh.)	310	0	.	0	0	.	1	8	1	0	4	2	.	3	1	1	5	0	0	15	0	1	.	1	1	.	.	8	8	12	7	5	83
Gaßweinstein	450	.	.	.	1	2	10	9	2	1	4	2	.	5	2	1	2	.	3	8	0	1	.	5	0	.	.	4	10	12	8	8	100
→ Schweinfurt	240	.	.	1	.	7	14	4	1	0	10	.	.	5	6	2	0	.	0	4	0	1	.	2	1	.	.	2	1	1	2	0	67
Würzburg (Wewa)	268	.	.	2	.	7	1	3	2	0	3	2	.	7	4	0	1	.	2	12	0	1	.	2	1	.	.	5	1	5	5	.	62
Ostheim/Rhön	315																																
Steinbach b. Lohr/Main	161	.	.	1	.	0	6	1	0	0	7	.	.	11	10	0	0	.	3	15	.	0	.	0	1	.	.	4	1	4	3	.	67
Frammersbach	245	.	.	2	.	0	18	1	0	0	7	0	.	15	4	0	.	0	12	10	.	0	.	0	1	.	.	7	1	2	4	0	84
Rothenburg o. d. Tauber	406	.	.	2	.	12	1	9	1	0	5	2	.	11	3	3	6	0	0	5	0	3	.	0	1	.	.	2	1	2	7	2	79
Kempten (Wst)	705	.	0	.	.	0	.	24	1	.	0	4	.	0	0	12	13	0	1	5	.	18	.	12	3	.	0	12	11	15	25	4	161
Krumbach/Hochhausen	520	.	.	.	.	0	4	11	1	0	0	2	.	.	1	4	19	.	7	1	0	5	.	2	6	.	.	4	7	6	10	3	94
Karlstein Neuhof	516	.	.	.	.	18	.	16	3	1	0	5	.	8	0	2	17	0	0	1	0	5	.	1	2	.	.	12	11	10	10	5	124
Schwangau Horn	796	.	.	.	.	0	.	4	1	2	0	3	.	.	.	13	12	0	0	30	.	23	.	0	4	.	.	10	24	38	39	3	208
Kaufering	585	.	.	.	.	.	.	16	1	0	1	1	.	5	.	8	16	.	8	6	.	18	.	7	2	.	.	10	9	12	23	6	147
Kösching	417	0	.	.	.	0	.	17	2	3	0	5	.	13	1	0	11	0	0	0	0	18	.	4	4	.	.	10	4	12	4	1	109
Au i. d. Hallertau-Günzenhausen	483	0	.	.	.	1	0	12	6	1	0	1	.	5	1	8	10	0	0	4	.	14	.	2	6	.	.	4	5	18	14	2	114
Parsberg/Opf.	542	1	.	.	.	.	.	18	3	1	3	5	.	10	5	3	8	.	0	11	.	19	.	1	3	.	.	21	13	18	9	.	150
Oberviechtach	498	.	.	.	.	2	.	6	6	.	1	5	.	18	6	1	10	.	0	21	0	21	.	.	5	.	.	13	21	29	10	1	175
Amberg Unterammersricht	386	.	.	.	.	.	7	23	2	0	1	3	.	1	2	1	7	.	.	16	.	14	.	0	2	.	.	1	8	19	6	5	117
Höllenstein Kraftwerk	403	.	.	1	.	.	0	1	9	3	1	2	.	16	3	4	10	1	.	9	.	23	.	.	12	.	.	8	24	31	15	2	174
Regensburg (Wst)	366	0	.	.	.	.	.	11	9	.	0	4	.	9	2	2	7	.	0	0	.	17	.	1	4	.	.	6	9	20	11	3	115
Weihenstephan (AMBF)	467	.	.	.	.	0	.	9	3	0	0	1	.	1	2	8	11	0	0	0	.	13	.	2	1	.	.	1	7	23	14	4	100
München Nymphenburg	515	.	.	0	.	3	.	5	2	0	0	13	.	0	0	11	20	0	1	4	.	20	.	2	0	.	.	3	6	25	17	3	136
Kumhausen	436	1	.	.	.	.	.	0	7	2	1	1	.	.	1	6	13	2	0	2	.	34	.	1	2	.	.	13	5	24	12	2	125
Freyung v. Wald	645	.	.	.	.	.	.	.	9	2	1	1	.	1	1	6	8	0	0	1	.	31	.	.	5	.	.	7	11	30	6	0	119
Rosenheim	446	0	.	.	.	.	.	3	7	2	.	3	.	.	10	9	9	0	.	6	.	19	.	1	4	.	.	2	17	20	37	3	150
Mühldorf/Inn (Wst)	401	13	.	.	.	.	.	1	5	0	0	2	.	1	2	7	14	2	.	0	.	17	.	0	1	.	.	14	10	20	10	3	122
Kötzing	611	0	.	.	.	.	.	2	11	2	1	3	.	1	10	11	12	1	.	5	.	26	0	.	2	.	.	24	24	26	32	2	196
Trostberg	487	1	.	.	.	0	.	1	4	3	0	4	.	.	29	10	12	0	.	4	.	22	.	0	4	.	.	24	15	18	16	0	166

List of Photos

Photos 1-128: Views of Terrain Units No. 1 to 128

Photos 129-130: Consecutive Terrain Conditions of Terrain Units No. 58/59 and No. 87/88

Photo 1: View of Terrain Unit No. 1

Photo 2: View of Terrain Unit No. 2

Photo 3: View of Terrain Unit No. 3

Photo 4: View of Terrain Unit No. 4

Photo 5: View of Terrain Unit No. 5

Photo 6: View of Terrain Unit No. 6

Photo 7: View of Terrain Unit No. 7

Photo 8: View of Terrain Unit No. 8


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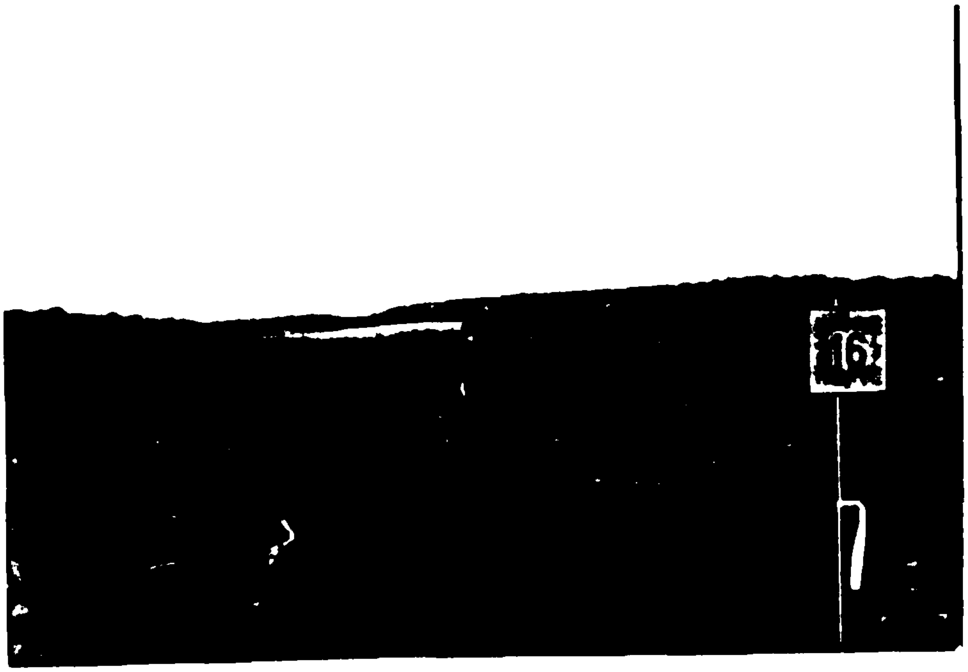
Photo 11: View of Terrain Unit No. 11

Photo 12: View of Terrain Unit No. 12


14


15


16

[illegible] View of Test Unit No. 17

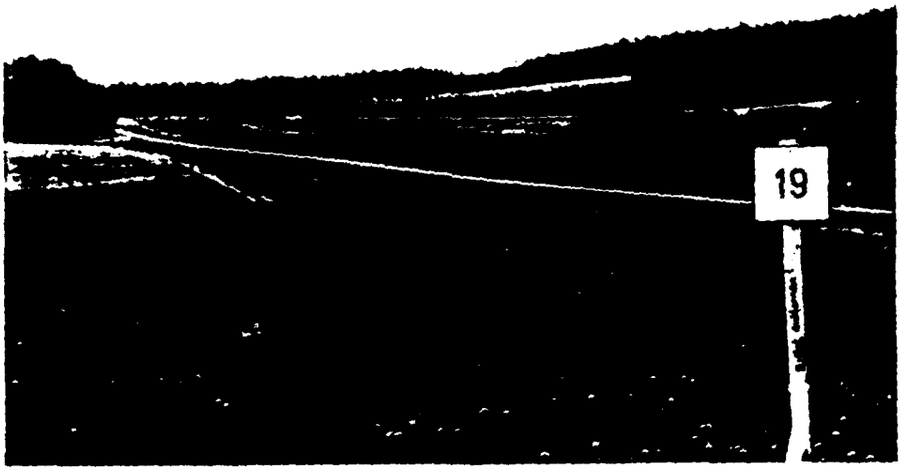


Figure 1.1: View of Terrain Unit No. 19

Figure 2.1: View of Terrain Unit No. 20

Photos 21 - 22 : View of Terrain Units No. 21 to 22

Photo 23: View of Terrain Unit No. 23

Photo 24: View of Terrain Unit No. 24

Photo 25: View of Terrain Unit No. 25

Photo 26: View of Terrain Unit No. 26

Photo 27: View of Terrain Unit No. 27

Photo 28: View of Terrain Unit No. 28

Photo 29: View of Terrain Unit No. 29

Photo 30: View of Terrain Unit No. 30

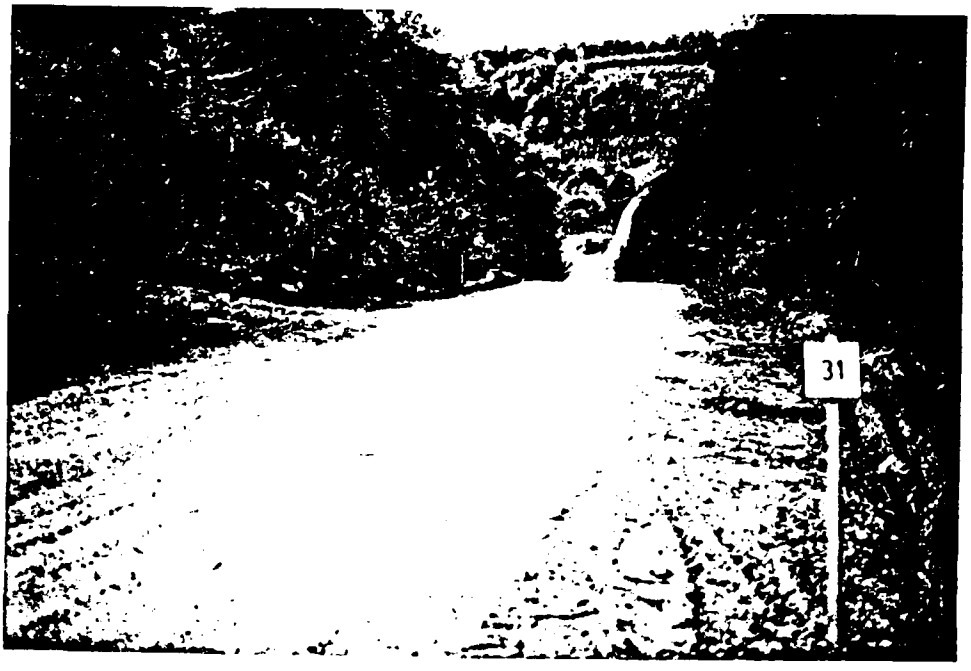


Photo 31: View of Terrain Unit No. 31

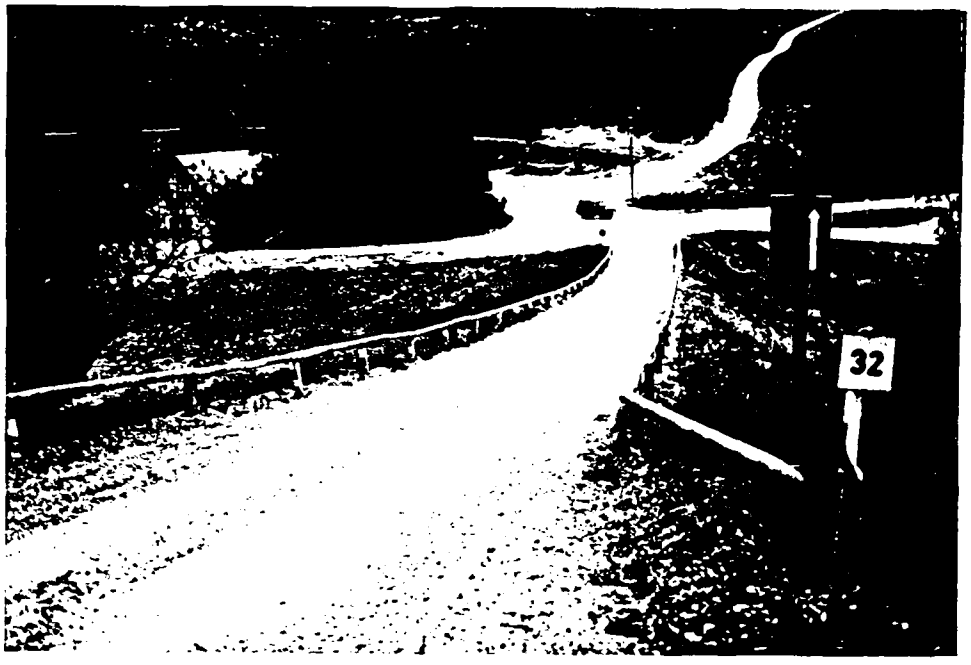


Photo 32: View of Terrain Unit No. 32

Photo 33: View of Terrain Unit No. 33

View of Terrain Part V - 34

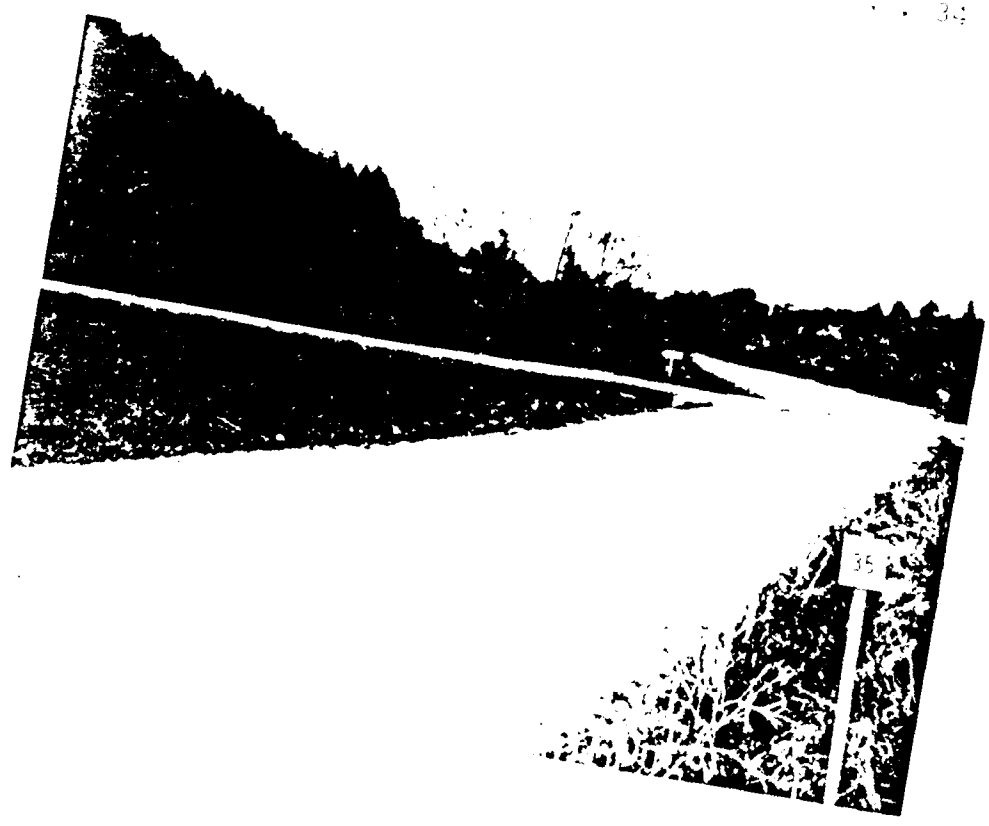


Photo 36: View of Terrain Unit No. 36

Photo 37: View of Terrain Unit No. 37

Photo 38: View of Terrain Unit No. 38

Photo 39: View of Terrain Unit No. 39

Photo 40: View of Terrain Unit No. 40

Photo 41: View of Terrain Unit No. 41

Photo 42: View of Terrain Unit No. 42

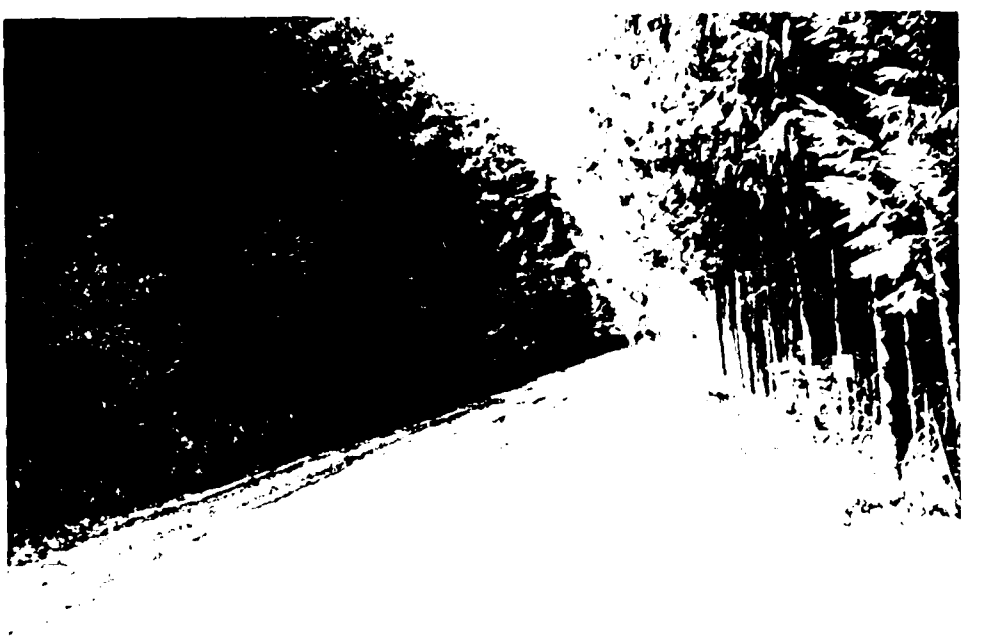


Fig. 40 View of Terrain Test No. 40

Fig. [illegible]

Figure 48: View of Terrain Unit No. 48

Figure 49: View of Terrain Unit No. 49

Photo 50: View of Terrain Unit No. 50

Photo 51: View of Terrain Unit No. 51

Photo 52: View of Terrain Unit No. 52

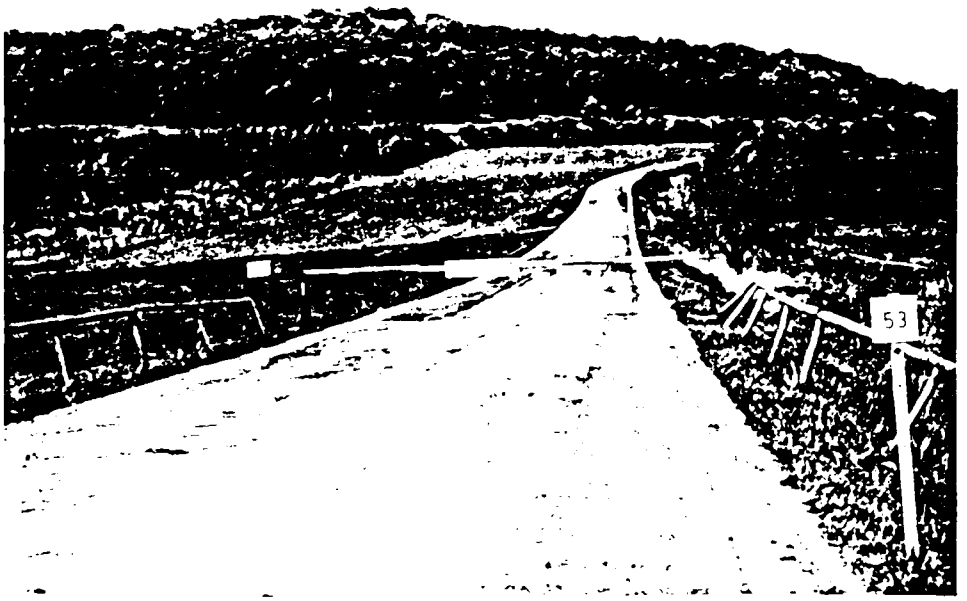


Photo 53: View of Terrain Unit No. 53

Photo 54: View of Terrain Unit No. 54

Photo 55: View of Terrain Unit No. 55

Photo 56: View of Terrain Unit No. 56

[illegible]

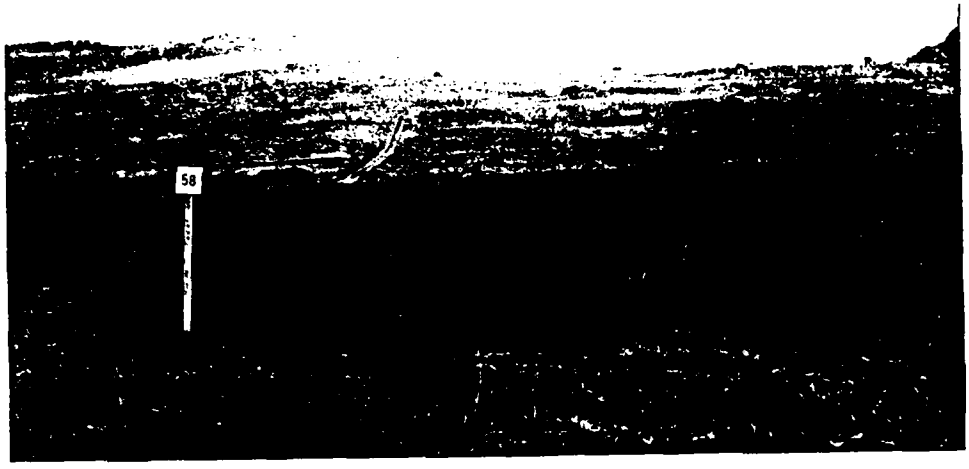


Photo 58: View of Terrain Unit No. 58

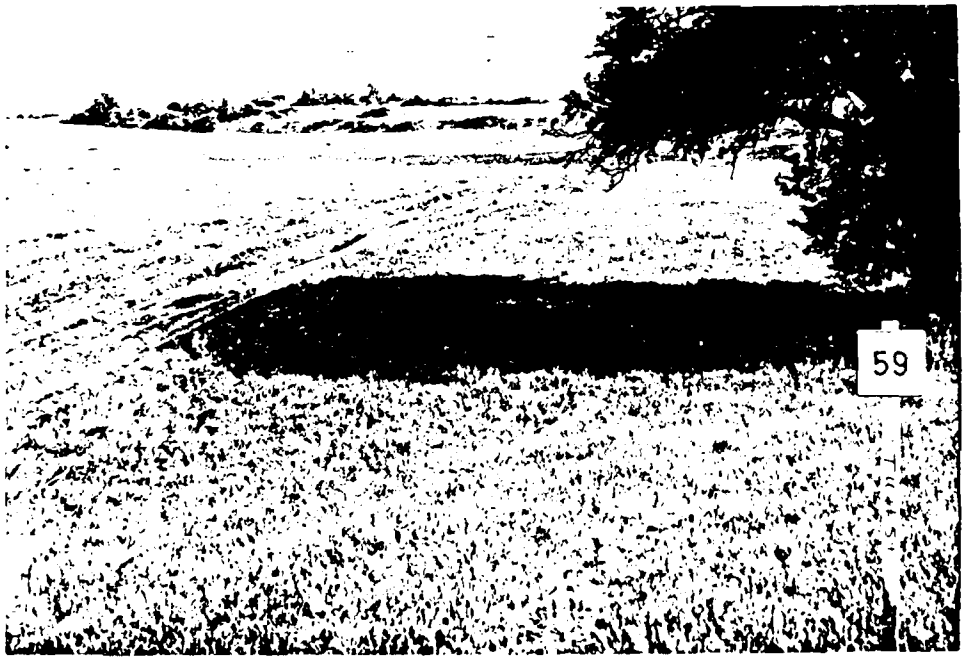


Photo 59: View of Terrain Unit No. 59

Photo 60: View of Terrain Unit No. 60

Photo 61: View of Terrain Unit No. 61

Photo 62: View of Terrain Unit No. 62

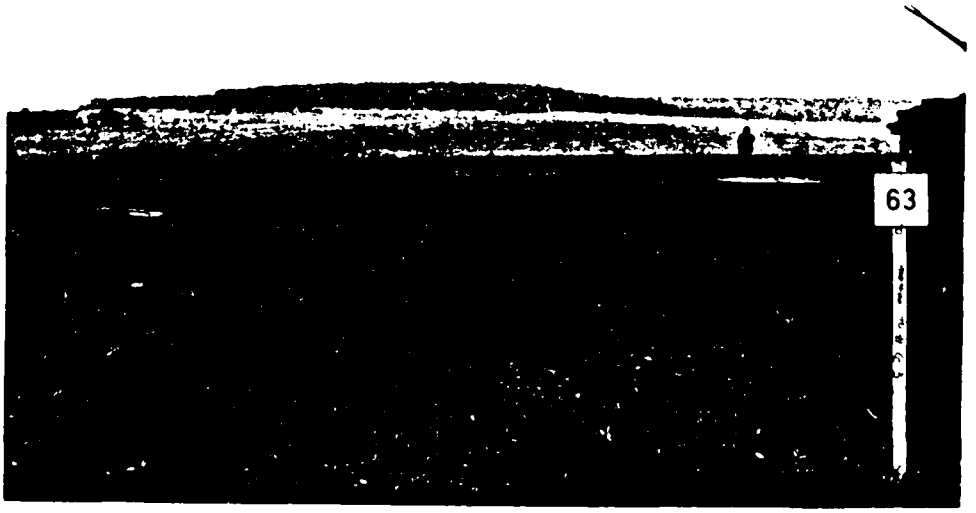


Photo 63: View of Terrain Unit No. 63

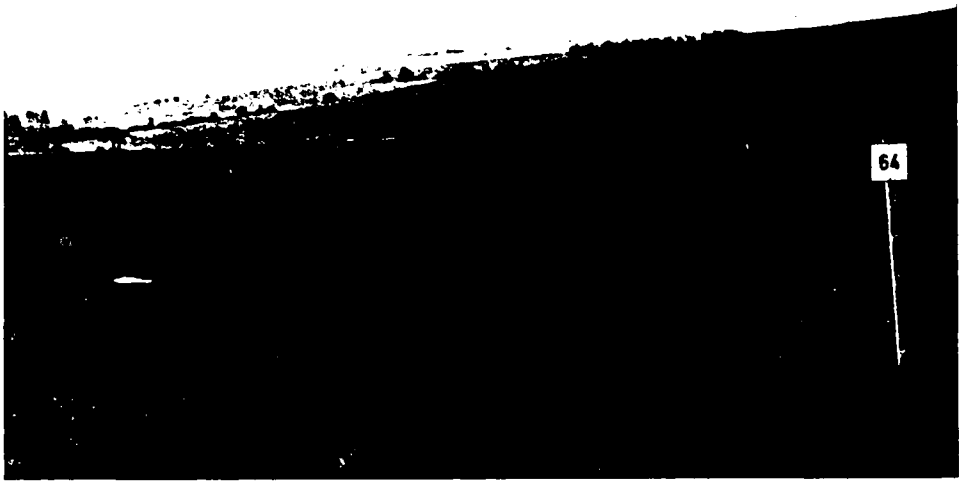


Photo 64: View of Terrain Unit No. 64

Photo 65: View of Terrain Unit No. 65

Photo 66: View of Terrain Unit No. 66

Photo 67: View of Terrain Unit No. 67

Photo 68: View of Terrain Unit No. 68

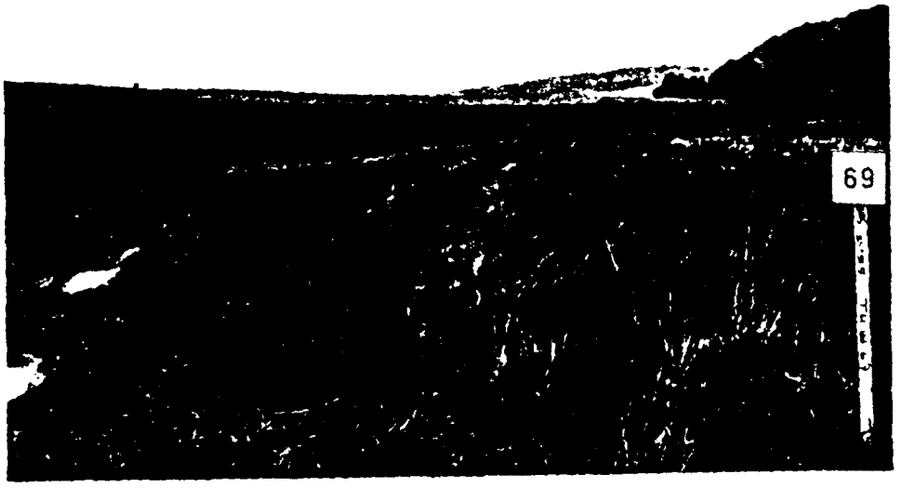


Photo 69: View of Terrain Unit No. 69

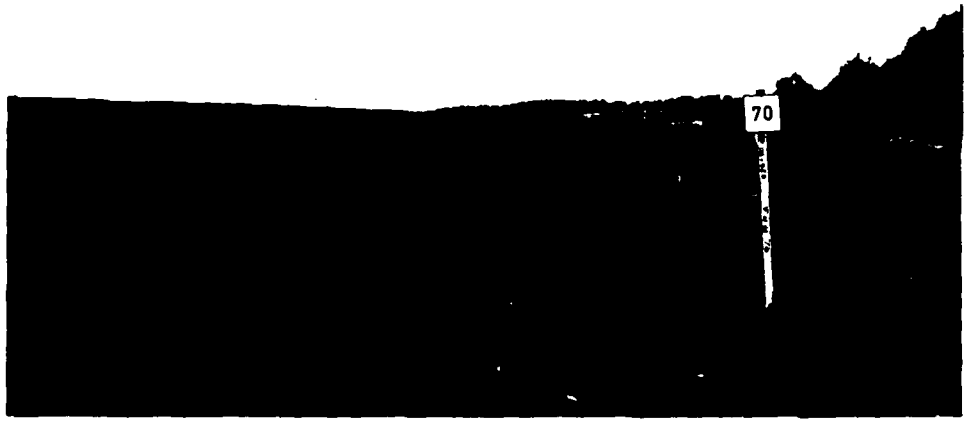


Photo 70: View of Terrain Unit No. 70

Photo 71: View of Terrain Unit No. 71

Photo 72: View of Terrain Unit No. 72

Photo 73: View of Terrain Unit No. 73

Photo 74: View of Terrain Unit No. 74

Photo 7o: View of Terrain Unit No. 7o

Photo 78: View of Terrain Unit No. 78

Photo 80: View of Terrain Unit No. 80

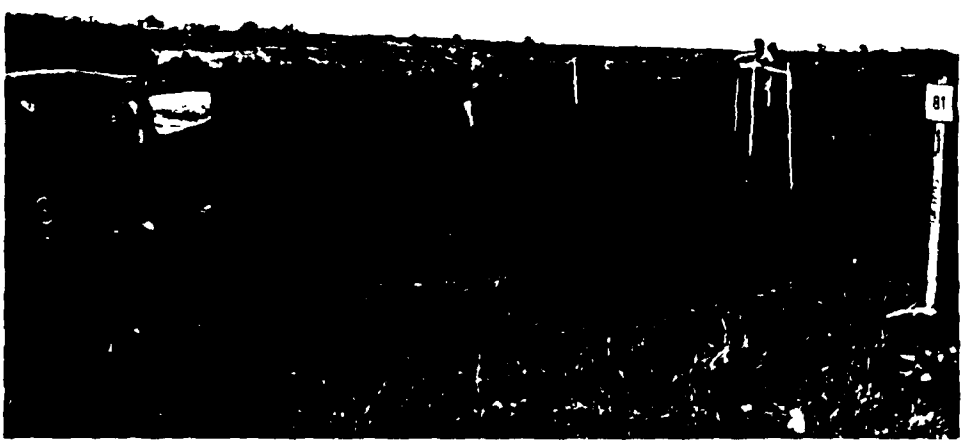


Photo 81: View of Terrain Unit No. 81

Photo 82: View of Terrain Unit No. 82

Photo 84: View of Terrain Unit No. 84

Photo 85: View of Terrain Unit No. 85

Photo 86: View of Terrain Unit No. 86

Photo 87: View of Terrain Unit No. 87

Photo 88: View of Terrain Unit No. 88

Photo 89: View of Terrain Unit No. 89

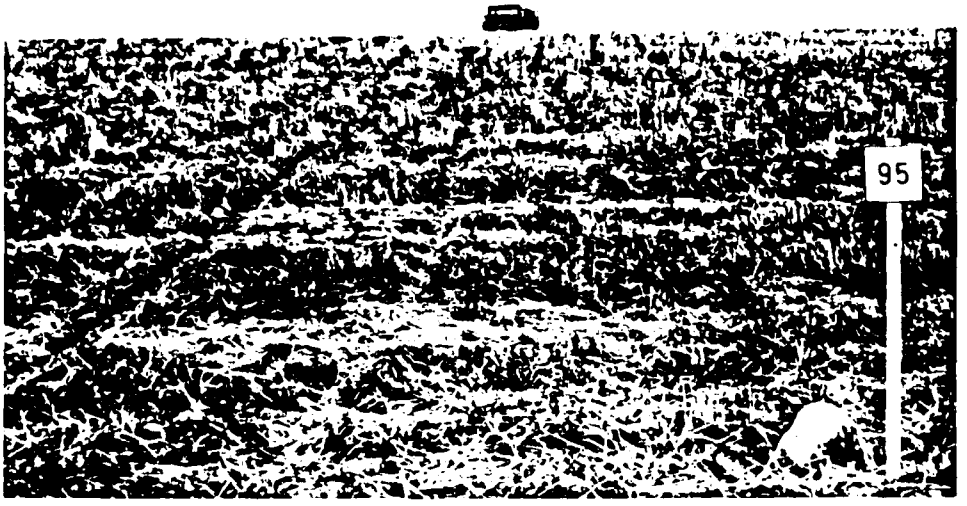
Photo 90: View of Terrain Unit No. 90

Photo [illegible]: View of Terrain Unit No. [illegible]

Photo 92: View of Terrain Unit No. 92

Photo 93: View of Terrain Unit No. 93

Bild 94: View of Terrain Unit No. 94



[illegible]

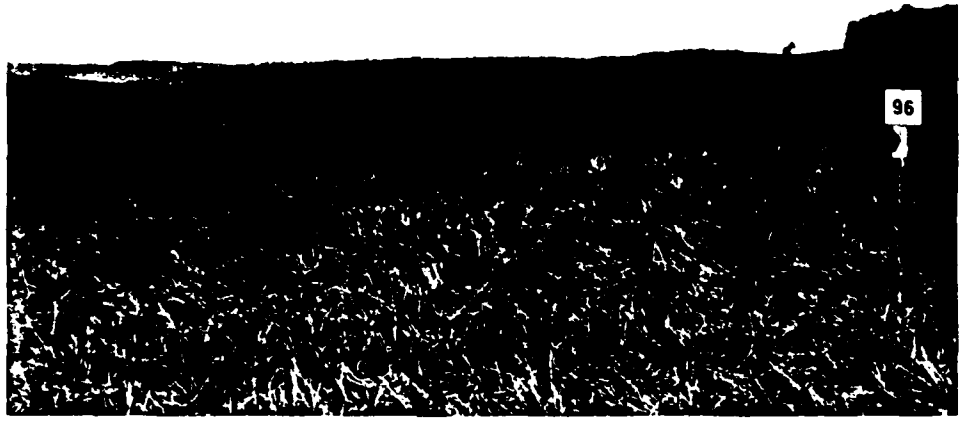


Photo 96: View of Terrain Unit No. 96

Photo 98: View of Terrain Unit No. 98

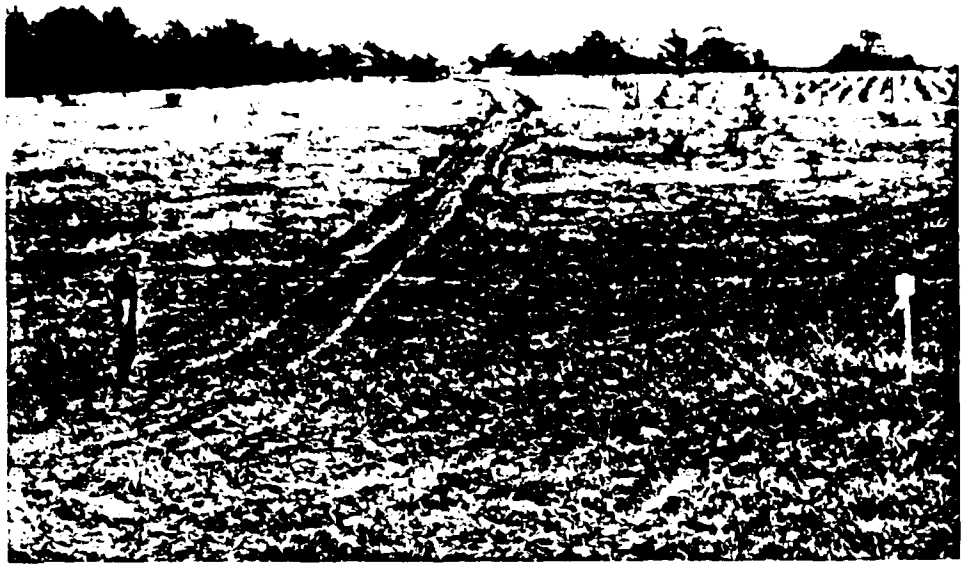


Plate I-1a View of Terrain Unit No. 100

Photo 112: View of Terrain Point No. 102


104


105

[illegible] View [illegible] Terrain Unit No. [illegible]


108

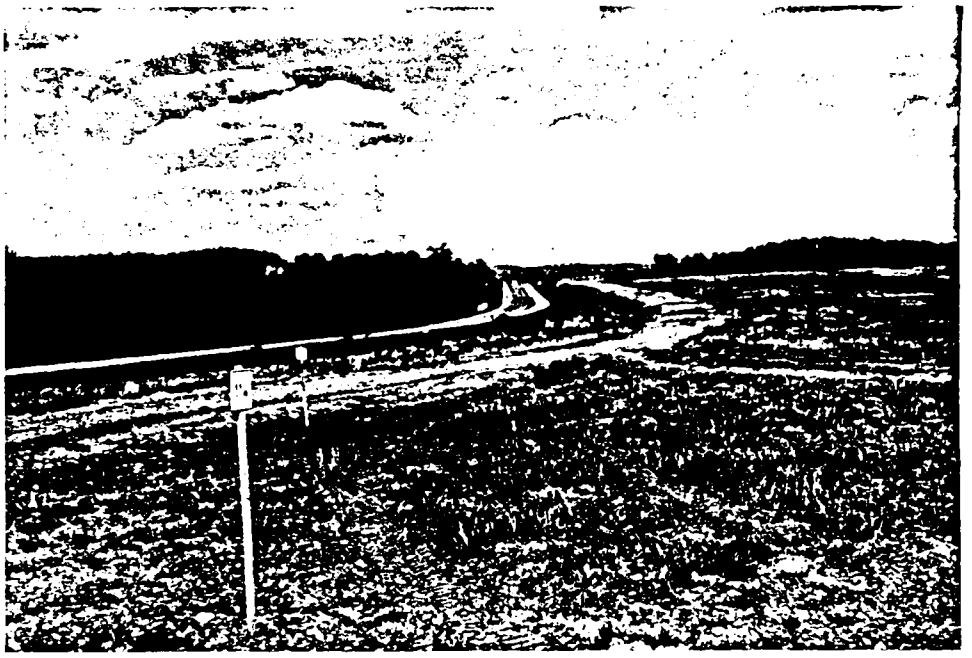

104

Photo 110: View of Terrain Unit No. 110

Photo 111: View of Terrain Unit No. 111

Photo 112: View of Terrain Unit No. 112

[illegible] No. 113



Photos 114-115: View of Terrain Units No.114 to 115

Photo 116: View of Terrain Unit No. 116

Photo 117: View of Terrain Unit No. 117

Photo 118: View of Terrain Unit No. 118

Photo 119: View of Terrain Unit No. 119

Photo 120: View of Terrain Unit No. 120

Photo 121: View of Terrain Unit No. 121

Photo 122: View of Terrain Unit No. 122

Photo 123: View of Terrain Unit No. 123

Photo 124: View of Terrain Unit No. 124

Photo 125: View of Terrain Point No. 125

Photo 127: View of Terrain Unit No. 127

View of Terrain Unit No. 128


16.05.86

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